(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
9 October 2003 (09.10.2003)

PCT

(10) International Publication Number
WO 03/082470 A1

(51) International Patent Classification[7]: B02C 7/14, D21B 1/14, D21D 1/30

(21) International Application Number: PCT/SE03/00530

(22) International Filing Date: 2 April 2003 (02.04.2003)

(25) Filing Language: Swedish

(26) Publication Language: English

(30) Priority Data:
0201023-9 2 April 2002 (02.04.2002) SE

(71) Applicant *(for all designated States except US)*: **METSO PAPER, INC.** [FI/FI]; P. O. Box 1220, FIN-00101 Helsinki (FI).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: **BACKLUND, Hans-Olof** [SE/SE]; Viljansvägen 25, S-860 25 Kovland (SE).

(74) Agents: **GROTH & CO. KB** et al.; Box 6107, S-102 32 Stockholm (SE).

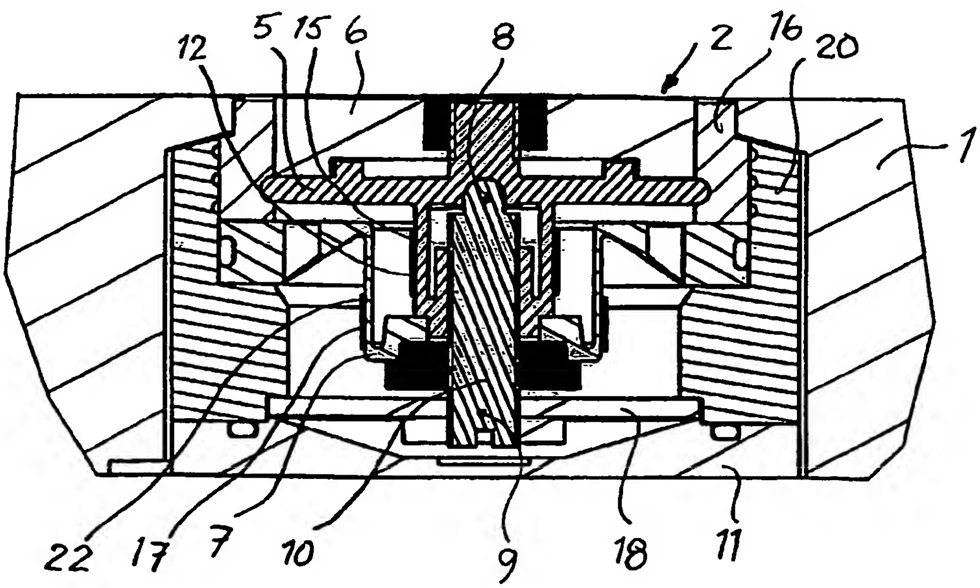
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD AND A DEVICE FOR MEASURING STRESS FORCES IN REFINERS



(57) Abstract: The inventions relates to a method for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material between bars (3) arranged on the refining discs. The measuring is performed over a measuring surface (2) that constitutes a part of a refining disc, said measuring surface comprising at least parts of more than one bar (3) and being resiliently arranged in the surface of the refining disc. Furthermore, forces in the plane of the measuring surface are measured and both the magnitude and the direction of the forces are measured simultaneously. The invention also relates to a device for performing said method.

WO 03/082470 A1

A METHOD AND A DEVICE FOR MEASURING STRESS FORCES IN REFINERS

The present invention relates to a method and a measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material.

Such refiners are used for refining fibrous material. The refiner generally comprises refining members in the form of discs rotating in relation to each other and between which refining material passes from the inner periphery of the refining members where it is supplied, to the outer periphery of the refining members through a refining gap formed between the refining members. One of the refining discs is often stationary while the other rotates. The refining discs are generally composed of segments provided with bars. The inner segments have a coarser pattern and the outer segments have a finer pattern in order to achieve fine refining of the refining material.

To obtain high quality refining material when refining fibrous material, the disturbances in operating conditions that, for various reasons, constantly occur must be corrected by constant adjustment of the various refining parameters to optimal values. This can be achieved, for instance, by altering the supply of water to produce greater or lesser cooling effect, by altering the flow of refining material or adjusting the distance between the refining members, or a combination of these measures. To enable the necessary adjustments and corrections an accurate determination of the energy transmitted to the refining material is required, as well as of the distribution of the energy transmitted over the surface of the refining members.

To determine the energy/power transmitted to the refining material it is already known to endeavour to measure the shearing forces that occur in the refining zone. What is known as shearing force occurs when two surfaces move in relation to each other with a viscous liquid between the surfaces. Such shearing force is also created in a refiner when refining wood chips mixed with water. It can be imagined that the wood chips are both sheared and rolled between the refining discs, as well as collisions occurring between chips and bars. The shearing force depends, for instance, on the force bringing the discs together and on the friction coefficient. The normal force acting on the surface also varies with the radius.

Through WO 00/78458 a method and a measuring device are already known for measuring stress forces in such refiners, the device comprising a force sensor that measures the stress force over a measuring surface constituting a part of a refining disc and in which said measuring surface comprises at least parts of more than one bar and is resilientlyarranged in the surface of the refining disc. However, it has been found that this measuring device is very sensitive to temperature fluctuations, which are usual in the applications under discussion, and it therefore often gives incorrect values for the force, which cannot be used to control the refining process, for instance. Furthermore, a value for the force in only one direction is obtained with this measurement. Another drawback is that other forces also appear that affect the refining segments, such as said normal forces, which are not taken into account.

The object of the present invention is primarily to solve the problems mentioned above and thus provide a method and a measuring device that gives a more complete and correct result than previously known devices.

The object is achieved by means of a method defined in claim 1 having the characteristics stated therein, and a measuring device as defined in claim 9.

In accordance with the method of the invention, therefore, the measuring is performed over a measuring surface that constitutes a part of a refining disc, said measuring surface comprising at least parts of more than one bar and being resiliently arranged in the surface of the refining disc, and it is characterized in that forces in the plane of the measuring surface are measured and both the magnitude and the direction of the force are measured simultaneously. The measuring device in accordance with the invention comprises members for measuring the stress force over the measuring surface which in turn constitutes at least a first set of force sensors for simultaneously measuring both the direction and magnitude of forces in the plane of the measuring surface.

The measurement in accordance with the method is preferably characterized in that it is performed with the aid of at least two force sensors, one of which is arranged to measure in an X-direction and the other is arranged to measure in a Y-direction, and in that magnitude and direction of the force influencing the measuring surface are determined as the resultant reading of the two force sensors. It should be pointed out here that X-direction and Y-direction, respectively, do not necessarily imply two directions forming a right angle with each other, but

these directions may form any angle at all as long as they do not coincide with each other.

The invention thus enables measurement of the shearing forces in two directions, thereby enabling both magnitude and direction of the resultant shearing force to be determined in any direction at all, which is an advantage.

In accordance with a preferred embodiment the measurement is characterized in that it is performed with the aid of at least four force sensors arranged in pairs opposite each other so that the two sensors in each pair give counter-directed deflection or readings, that said pairs are arranged at right angles to each other to measure in an X-direction and a Y-direction, and in that the magnitude and direction of the force are determined as the resultant reading, i.e. the measured stress forces of each pair of force sensors. The use of sensors arranged in pairs giving counter-directed readings, offers the important advantage that a value can be obtained for the stress force that is not affected by occurring temperature fluctuations. This is achieved by utilizing the difference between the readings of the force sensors in the relevant pair, measured on each occasion, as the value of the stress force in each direction. This value can then be utilized to calculate the magnitude and distribution of the power transmitted to the refining material and these calculations can then be used to control the refining process. In this context reference is also made to Swedish patent application No. 0102845-5 filed by the same applicant.

Utilizing pairs of counter-directed sensors in the manner defined in the present invention offers the advantage that any measuring errors are halved for each direction.

In accordance with another advantageous feature the invention is characterized in that the measurement of said forces in the plane of the measuring surface also includes compensation for any eccentric normal forces on the measuring surface that would affect said measurement.

In accordance with an additional advantageous feature the method is characterized in that forces directed at right angles to the measuring surface are also measured. This method preferably includes measurement of the normal force exerted by a combined pressure consisting of the steam pressure inside the refiner and the fibre pressure from the refining material. An alternative choice is to measure a normal force that is a result of only the pressure of the fibre mat.

The measuring device in accordance with the invention comprises suitable devices for performing the method.

In accordance with a particularly advantageous embodiment the force sensors comprise strain gauges. A particular advantage of this is that the actual measuring device will be relatively small and low, thus allowing it to be fitted directly in the refining segment.

Further advantages and features are revealed in the dependant claims.

The present invention will now be described with reference to the embodiments illustrated in the accompanying schematic drawings, in which:

Figure 1 shows a perspective view of a refining segment included in a refining disc which is provided with measuring devices in accordance with the present invention,

Figure 2 shows a basic layout sketch in accordance with the present invention,

Figure 3 shows a view, in cross section, of a first embodiment of a measuring device in accordance with the present invention,

Figure 4 shows a basic layout sketch of the embodiment illustrated in Figure 3,

Figure 5 shows a view, in cross section, of a second embodiment of a measuring device in accordance with the present invention,

Figure 6 shows a basic layout sketch of the embodiment illustrated in Figure 5, and

Figure 7 shows a schematic cross section of only the thin-walled tubular parts of the first and the second body, and the strain gauges arranged thereon.

Figure 1 thus shows a part of a refining disc in the form of a refining segment 1, provided with a pattern comprising a number of bars 3 extending substantially in radial direction. Measuring devices 4 in accordance with the present invention are also drawn in schematically in this figure. These measuring devices have a preferably circular measuring surface 2 with a diameter in the order of 30 mm, for instance, but the measuring surface may alternatively have a different geometric shape. The measuring devices are preferably arranged at different radial distances from the centre of the refining disc, and segments at different distances from the centre preferably also have measuring devices. The measuring devices

can also advantageously be displaced peripherally in relation to each other to enable them better to determine the power distribution in the refiner and thus better control the refining process. When a measuring device is influenced by forces, each of the force sensors will generate a signal that is proportional to the load.

The measuring device in accordance with the invention functions in accordance with the principle illustrated in Figure 2. We see here a measuring surface 2 in the form of part of the surface of a refining segment, provided with a number of bars 6, or at least parts thereof. The measuring device includes an attachment element in the form of a rod 10, with the aid of which the various parts of the device are secured and which also joins the various parts of the measuring device to each other and to the measuring surface 2. The rod has two fulcrums, a first, upper fulcrum 8 for a first body 5 and a second, lower fulcrum 9 for a second body 7. Compare also Figures 3 and 5. The first body 5 is provided with a first set of power sensors (12 in Figures 3 and 5, respectively). This first body connects the measuring surface 2 with the rod 10 so that, when the refining disc is subjected to a shearing force F_s, the torque M_1 in the first fulcrum 8 or torque point will be:

$$M_1 = F_s \cdot l_1 \qquad (1)$$

where l_1 is the distance between the measuring surface 2 of the measuring device and the fulcrum 8.

The second body 7 with a second set of force sensors (22 in Figures 3 and 5, respectively) is arranged in conjunction with the second, lower fulcrum 9. This second body is connected to the rod 10 so that, when the refining disc is subjected to a shearing force F_s, the torque M_2 in the second fulcrum 9 or torque point, will be:

$$M_2 = F_s \cdot l_2 \qquad (2)$$

where l_2 is the distance between the measuring surface 2 of the measuring device and the fulcrum 9.

The torques in the fulcrums are obtained with the aid of the readings of

the force sensors and, on the basis of these, the shearing force F_s can be calculated.

Thanks to the arrangement with a second set of force sensors it is possible to compensate the values obtained for the shearing force F_s with regard to any asymmetric or eccentric normal forces, i.e. forces in the normal direction, perpendicular to the measuring surface which, due to their point of attack not being the centre of the measuring surface 2 since they are displaced from the centre, influence the force sensors as if they were shearing forces. The following equations are obtained:

$$M_1 = F_s \cdot l_1 + F_N \cdot l_N \qquad (3)$$

$$M_2 = F_s \cdot l_2 + F_N \cdot l_N \qquad (4)$$

where F_N is in this case an eccentric normal force and l_N is the distance between the central axis and the point of attack of the eccentric normal force.

The equations (3) and (4) material the following expression for the shearing force, which is utilized in the measuring device:

$$F_s = \frac{M_2 - M_1}{l_2 - l_1} \qquad (5)$$

If no eccentric normal force occurs to influence the measuring surface, it would be sufficient with only one set of force sensors and one body.

Figure 3 shows a preferred embodiment of a measuring device in accordance with the invention. The measuring device 4 comprises a measuring surface 2 provided with bars 6, or parts of bars, which measuring surface constitutes a part of a refining segment as illustrated in Figure 1. As is also clear in Figure 1, the measuring device preferably has a circular measuring surface. The measuring device and the measuring surface are movably arranged in the refining segment 1, in all directions.

The measuring surface 2 is in direct contact with a first, upper body 5 extending inside the device. At its lower side this first body is shaped as a thin-walled tube 15. The material is chosen to be somewhat resilient. A cross section

through the thin-walled tube section can therefore be likened to a spring, as illustrated in Figure 4. Strain gauges are arranged on the outside of the thin-walled tube section, which form a first set of force sensors 12. Really it is the thin-walled, somewhat resilient tube section that, together with the strain gauges, forms the force sensors, but for the sake of simplicity the term force sensor is used in this description primarily as a designation for the strain gauges or equivalent members. The strain gauges are preferably arranged axially and when the thin-walled tube is subjected to a load it is slightly deformed so that it influences the strain gauges. These are in turn connected to some suitable strain gauge bridge that generates a corresponding signal. The thin-walled tube section 15 is pre-stressed with a tensile force so that it does not risk collapsing when subjected to loading.

Inside the tube section extends a rod 10 with spherical top, which rod forms the previously mentioned attachment element. Said first body 5 is journalled on the spherical top which thus functions as a fulcrum for the body 5 and forms said first fulcrum 8. This embodiment comprises four sensors arranged symmetrically in relation to a centre line extending through the measuring surface 2 and through the rod 10. The sensors 12 are preferably arranged with 90° spacing, see also Figure 7. They are arranged in pairs opposite each other so that the sensors in a pair will give counter-directed deflection /readingwhen influenced by a force. When the pressure on the measuring surface 2 increases, the load on one of the sensors will increase while at the same time it will decrease on the other sensor in a pair. The stress force can therefore be calculated on the basis of the difference between the readings measured at any one time on respective force sensors in a pair. It would naturally be possible to arrange the sensors differently in relation to each other and still have their respective readings be counter-directed. Said pairs of sensors are also arranged perpendicular to each other for measuring in an X-direction and a Y-direction, i.e. in a plane parallel with the measuring surface 2. This permits measurement of forces in all directions in a plane parallel with the measuring surface, the magnitude and direction of the force being determined as the resultant of the readings of respective pairs of force sensors (see also Figure 4).

A second, lower body 7 is arranged below the first, upper body 5 and outside its tubular part 15. This second body also has a thin-walled tubular part 17, arranged outside and concentric with the tubular part 15 of the first body 5 and

with the rod 10, and functioning in corresponding manner, i.e. as a spring. Strain gauges are also arranged on the outside of the second thin-walled tubular part 17. Said strain gauges form a second set of force sensors 22 and are preferably arranged axially. They are four in number and are arranged symmetrically in relation to a centre line extending through the measuring surface 2 and through the rod 10. In other respects they are arranged in the same way and function in the same way as the sensors 12 of the upper body 5, i.e. they are arranged in pairs and measure forces in X- and Y-direction, see also Figure 7. However, in the example illustrated the fulcrum 9 for the lower body 7 is formed by the central point of a resilient plate or sheet 18 arranged below the body 7 and connected to the rod 10 so that the rod extends through the centre of the plate.

The fulcrum 9 may alternatively be designed as a waist on the rod 10, preferably arranged immediately above the point at which the plate 18 is located, see also Figure 5.

The rod 10 preferably has screw threading and the first, upper body 5 is preferably screwed onto the rod. The second, lower body 7 may suitably be attached to the rod by means of a nut.

The measuring device in the example illustrated also comprises means for measuring forces directed at right angles to the measuring surface, i.e. normal forces, i.e. forces in Z-direction as illustrated in Figure 4. The normal force is a resultant of the steam pressure in the refiner and the pressure exerted against the measuring surface (and the refining segment) by the fibre mat formed by the refining material. For this purpose the measuring surface is resiliently arranged in a direction perpendicular to the measuring surface, also illustrated schematically in Figure 4. In accordance with one embodiment the normal forces can be measured with the aid of additional strain gauges forming force sensors 32, arranged on one or other of the tubular parts 15 or 17, preferably axially between the already existing sensors, as illustrated schematically in Figure 7. To obtain a fairly correct measurement, at least three force sensors should be used for measuring the normal force, and these should be uniformly distributed. However, the use of four sensors is preferred, as shown in Figure 7, or possibly more.

The internal parts of the measuring device described above are arranged in a protective sensor housing 20. This housing is provided with an opening at the top, which is adjacent to the surrounding refining segments, and which is closed

off from the refining material, by said measuring surface 2 and a resilient seal 16 between the measuring surface and the side walls of the sensor housing. The housing is also closed off at the bottom, towards the stator of the refiner or segment holder if such is used, by a lid 11. The seal 16 is of a particularly suitable, somewhat resilient material, e.g. rubber, so that it can permit the small movements that the shearing forces give rise to in the measuring surface and still provide a good seal preventing steam and pulp from penetrating into the device. The seal preferably also has a dampening effect on, inter alia, the vibrations occurring during operation. In this context it may be mentioned that the load can vary considerably over the refining zone from in the order of 20N to in the order of 150N, for instance. In the present case, at an estimated mean value of approximately 40N, displacements of the measuring surface that can be measured in the order of hundredths of a millimetre are obtained.

Figures 5 and 6 illustrate a second embodiment of the invention in which compensation can take place for the steam pressure that exists in the refiner and which constitutes a part of the normal force pressure on the measuring surface that is measured with the measuring device in accordance with the first embodiment. As mentioned earlier the normal force F_N, which affects the measuring surface, comprises both the force from the fibre pressure F_{Fib} exerted by the fibre mat formed by the refining material in the refiner, and also the force from the steam pressure F_S that prevails inside the refiner. It is often of interest to obtain a measurement of the fibre pressure on its own. Parts in this figure corresponding to parts in Figures 3 and 4 have been given the same reference numerals. Thus this embodiment also comprises a first body 5 and a second body 7, each provided with thin-walled tubular parts 15 and 17, respectively, on which a first and second set of force sensors 12 and 22, respectively, are arranged. The second tubular part 17 is here provided with special force sensors for measuring the normal force, in the form of strain gauges 32 arranged preferably axially between the already existing sensors, as illustrated schematically in Figure 7. Alternatively, these sensors for measuring the normal force could be placed on the tubular part 15 of the first body 5. It also comprises a rod 10 and a plate-like spring member 18, preferably in the form of four crossing legs whose function here is to secure the various parts of the measuring device from below. The internal parts of the measuring device are also located in a protective sensor housing 20. Contrary to

the embodiment in Figure 3, however, the lid closing off the sensor housing from the stator or segment holder is designed so that a connection exists between the upper side of the measuring surface and the upper side of the surrounding refining segment via an open channel 13 arranged between the side walls of the sensor housing 20 and the surrounding refining segment 1. The aim is that compensation can be achieved for the existing steam pressure when the normal force affecting the measuring surface 2 is calculated. For this purpose the existing steam pressure shall also affect the parts of the measuring device that measure the perpendicular pressure in the direction opposite to the normal pressure, i.e. from below. The lid 11 may thus be made in two parts, an outer part 23 provided with channels and an inner, movable part 24 having a gap between it and the stator/segment holder. The rod 10 is also shaped so that a gap exists between it and the stator/segment holder. Steam can thus penetrate to said gap 25 formed above the stator/segment holder and there influence the inner part 24, rod 10 and force sensors 32 on the part 17, or possibly other members that have been mentioned and can form said members for measuring perpendicular forces. The steam pressure acting on the measuring surface and the steam pressure acting from below thus cancel each other out and a measurement of the actual fibre pressure can be obtained.

It should be pointed out that the method and device for measuring perpendicular forces or normal forces, with or without compensation for the steam pressure, can be used as a separate invention and possibly combined with other devices for measuring shearing forces.

It is also possible to omit the compensation for eccentric normal forces and have only one set of force sensors, one body and one fulcrum in the device.

It should also be mentioned that it is perfectly possible to use other types of force sensors than strain gauges in combination with thin-walled resilient tubes.

The invention shall not be considered limited to the embodiment illustrated, but can be modified and altered in many ways by one skilled in the art, within the scope of the appended claims.

CLAIMS

1. A method for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material between bars (3) arranged on the refining discs, the measuring being performed over a measuring surface (2) that constitutes a part of a refining disc, and said measuring surface comprising at least parts of more than one bar (3) and being resiliently arranged in the surface of the refining disc, **characterized in** that forces in the plane of the measuring surface are measured and both the magnitude and the direction of the force are measured simultaneously.

2. A method as claimed in claim 1, **characterized in** that the measurement is performed with the aid of at least two force sensors (12; 22), one of which is arranged to measure in an X-direction and the other is arranged to measure in a Y-direction, and in that magnitude and direction of the force influencing the measuring surface are determined as the resultant reading of the two force sensors.

3. A method as claimed in claim 2, **characterized in** that the measurement is performed with the aid of at least four force sensors (12; 22) arranged in pairs opposite each other so that the two sensors in each pair give counter-directed readings, that said pairs are arranged at right angles to each other to measure in an X-direction and a Y-direction, and in that the magnitude and direction of the force are determined as the resultant reading of each pair of force sensors.

4. A method as claimed in any one of the preceding claims, **characterized in** that the measurement of said forces in the plane of the measuring surface also includes compensation for any eccentric normal forces on the measuring surface that would affect said measurement.

5. A method as claimed in any one of the preceding claims, **characterized in** that forces directed at right angles to the measuring surface are also measured.

6. A method as claimed in claim 5, **characterized in** that the measurement of forces directed at right angles to the measuring surface includes measurement of the normal force exerted by a combined pressure consisting of the steam pressure inside the refiner and the fibre pressure from the refining material.

7. A method as claimed in claim 5, **characterized in** that the measurement of forces directed at right angles to the measuring surface includes measurement of the normal force exerted by only the fibre pressure of the refining material, by compensation being made for the steam pressure existing inside the refiner.

8. A method as claimed in claim any one of the preceding claims, **characterized in** that the magnitude and distribution of the power transmitted to the refining material are calculated on the basis of the reading measured on respective force sensors and in that the calculations are then used to control the refining process.

9. A measuring device for measuring stress forces in refiners having refining discs that between them define a refining gap for refining material between bars (3) arranged on the refining discs, which measuring device comprises members for measuring the stress force over a measuring surface (2) that constitutes a part of a refining disc, said measuring surface comprising at least parts of more than one bar (3) and being resiliently arranged in the surface of the refining disc, **characterized in** that said members for measuring the stress force over the measuring surface comprise at least a first set of force sensors (12) for simultaneous measurement of both direction and magnitude of the forces in the plane of the measuring surface.

10. A measuring device as claimed in claim 9, **characterized in** that it comprises a means for compensating for any eccentric normal forces in the plane of the measuring surface that would affect said measurement.

11. A measuring device as claimed in either of claims 9-10, **characterized in** that it also comprises members (32) that measure forces directed at right angles to the measuring surface.

12. A measuring device as claimed in any of claims 9-11, **characterized in** that said first set of force sensors comprises at least two force sensors (12), one of which is arranged to measure in an X-direction and the other is arranged to measure in a Y-direction, and in that magnitude and direction of the force influencing the measuring surface are determined as the resultant reading of the two force sensors.

13. A measuring device as claimed in claim 12, **characterized in** that said first set of force sensors comprises at least four force sensors (12), arranged in pairs opposite each other so that the two sensors in each pair give counter-directed readings when the measuring surface is influenced by said stress force, in that said pairs of force sensors are arranged at right angles to each other to measure in an X-direction and a Y-direction, and in that the magnitude and direction of the force are determined as the resultant reading of each pair of force sensors.

14. A measuring device as claimed in any one of claims 9-13, **characterized in** that it comprises a first body (5) that connects the force sensors (12) of the first set of force sensors to the measuring surface (2), that said first body comprises a tubular resilient part (15) arranged around the central axis of the measuring surface and in that the force sensors are arranged on said tubular part.

15. A measuring device as claimed in any one of claims 9-14, **characterized in** that said member for measuring the stress force over the measuring surface also includes a second set of force sensors (22).

16. A measuring device as claimed in claim 15, **characterized in** that it comprises a second body (7) that connects the force sensors of the second set of force sensors to the measuring surface (2), that said second body comprises a tubular resilient part (17) arranged around the central axis of the measuring sur-

face and in that the force sensors (22) are arranged on said second tubular part (17) in corresponding manner to the way in which the first set of force sensors (12) are arranged on the first tubular part (15).

17. A measuring device as claimed in claim 16, **characterized in** that said second set of force sensors (22) and said second body (7) form the arrangement for compensation of eccentric normal forces.

18. A measuring device as claimed in claim 14, **characterized in** that said member for measuring perpendicular forces comprises at least three force sensors arranged axially on the tubular part (15) of said first body (5).

19. A measuring device as claimed in claim 16, **characterized in** that said member for measuring perpendicular forces comprises at least three force sensors (32) arranged axially on the tubular part (17) of said second body (7).

20. A measuring device as claimed in claim 11, or 18-19, **characterized in** that said member for measuring perpendicular forces comprises means for measuring the normal force exerted on the measuring surface, with or without compensation for the steam pressure existing inside the refiner.

21. A measuring device as claimed in any one of claims 9-20, **characterized in** that said force sensors comprise strain gauges.

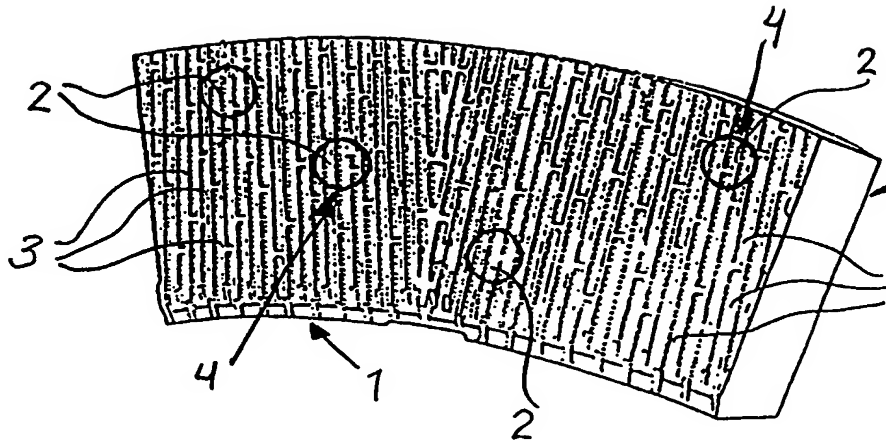


Fig. 1

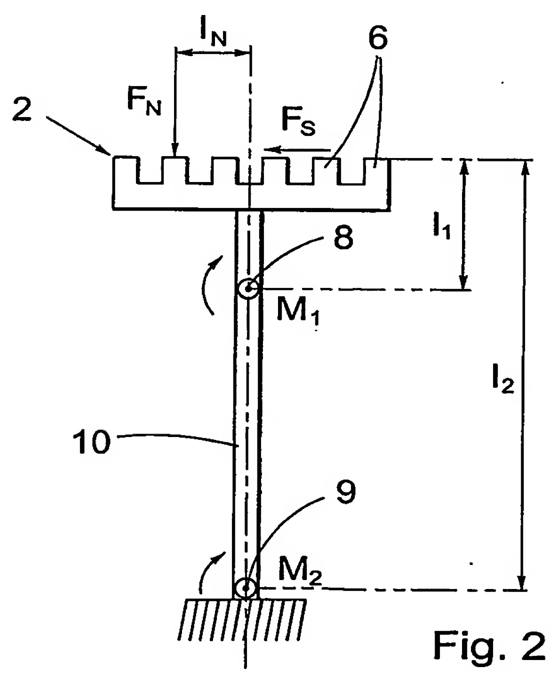


Fig. 2

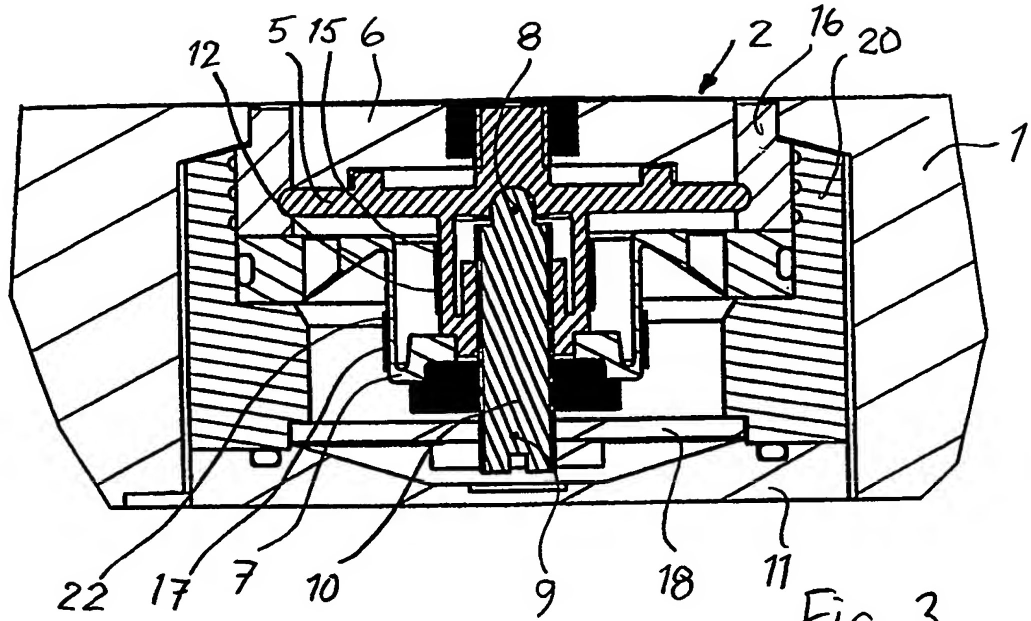


Fig. 3

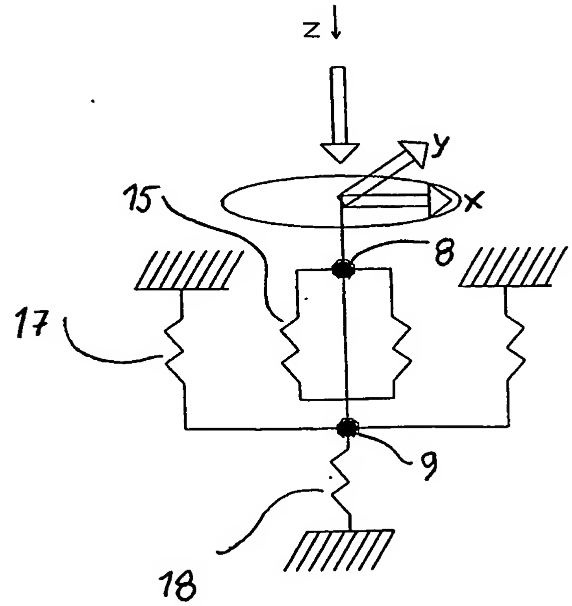
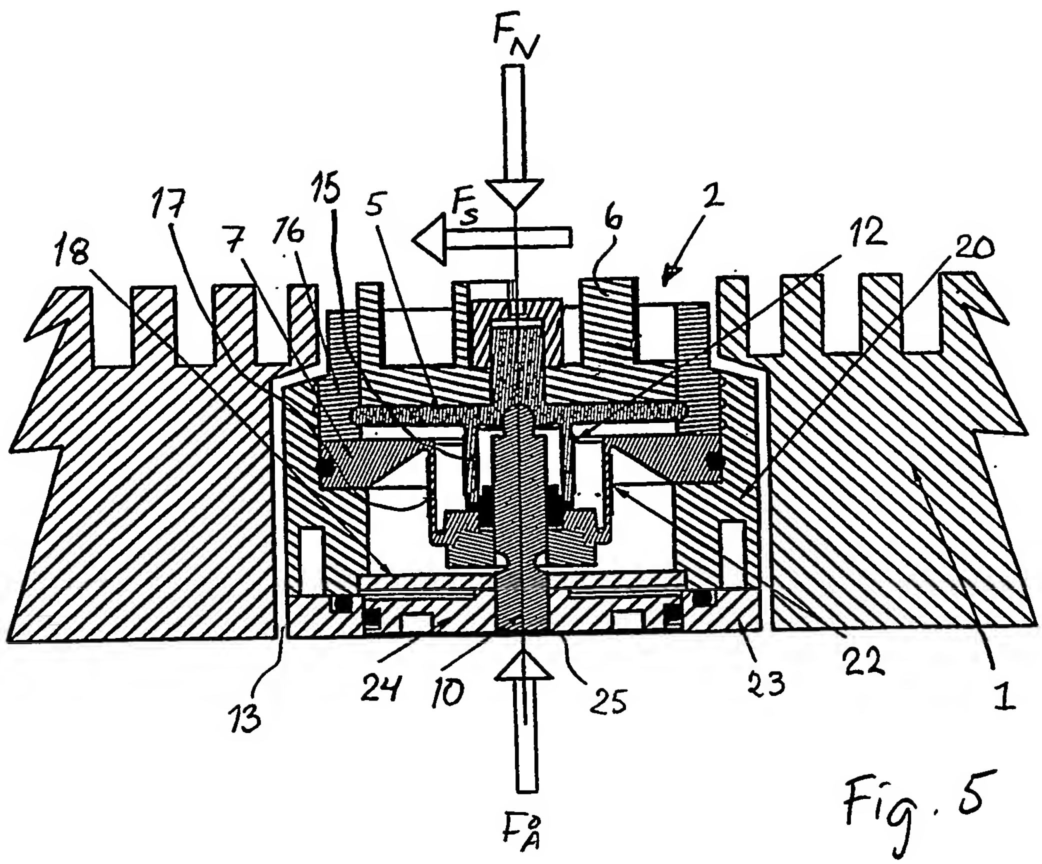
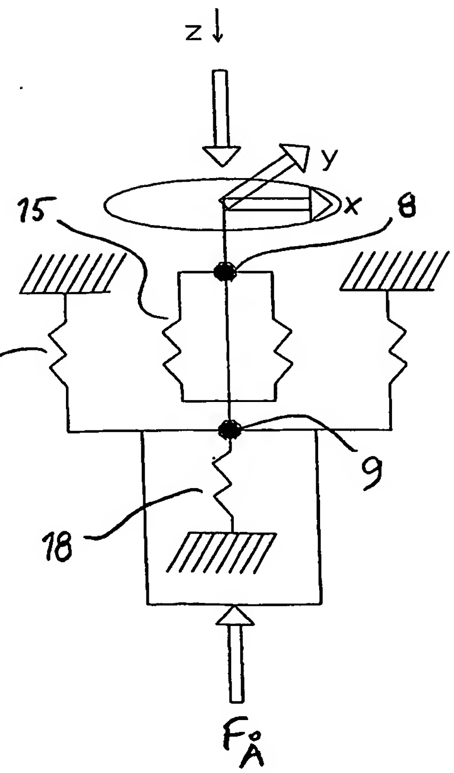


Fig. 4



F_N
F_S
18
17
7
16
15
5
6
2
12
20
13
24
10
25
23
22
1
$F_{\AA}$

Fig. 5



z
y
x
15
8
17
9
18
$F_{\AA}$

Fig. 6

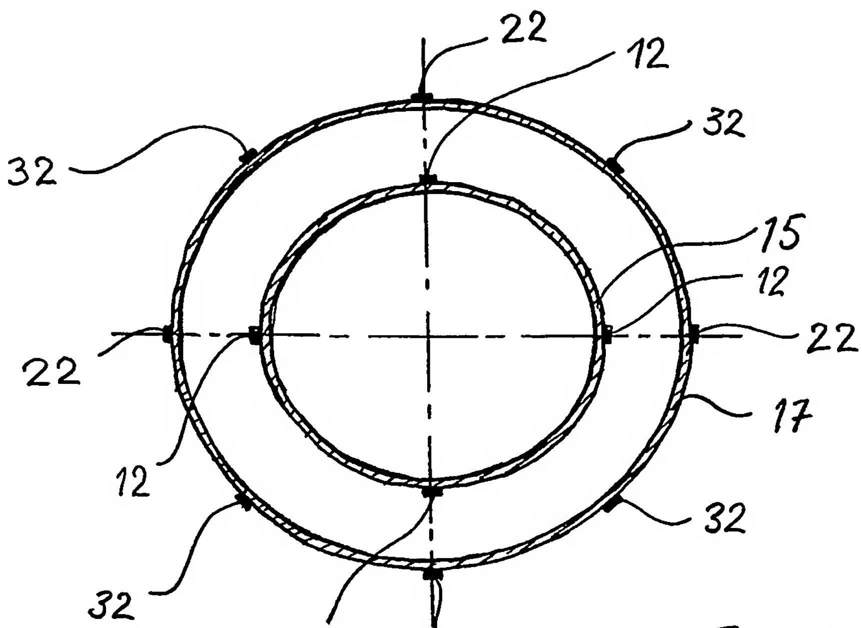


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 03/00530

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B02C 7/14, D21B 1/14, D21D 1/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B02C, D21B, D21D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	SE 514841 C2 (VALMET FIBERTECH AB), 30 April 2001 (30.04.01), page 5, line 15 - page 6, line 10, figures 1,4, claim 1 -- --------	1-21

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 May 2003	17-06-2003
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Wiva Asplund/MP Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

29/04/03

International application No.
PCT/SE 03/00530

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
SE 514841 C2	30/04/01	AU 3088900 A	12/07/00
		AU 5861400 A	09/01/01
		BR 9916278 A	04/09/01
		CA 2352309 A	29/06/00
		CA 2375059 A	28/12/00
		EE 200100309 A	15/08/02
		EP 1140159 A	10/10/01
		EP 1200193 A	02/05/02
		HR 20010433 A	30/06/02
		HU 0104552 A	29/04/02
		IL 143808 D	00/00/00
		JP 2002532562 T	02/10/02
		NO 20012889 A	12/06/01
		PL 348257 A	20/05/02
		SE 9902306 A	18/12/00
		WO 0078458 A	28/12/00